

REMARKS

In section 4 of the Office Action, the Examiner rejected claims 1 and 2 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath.

Independent claim 1 is directed to an apparatus having a non-ferromagnetic compressor wheel of a turbocharger, a permanent magnet, and at least one magnetoresistor. The non-ferromagnetic compressor wheel has fins. The permanent magnet is positioned so as to induce eddy currents on the fins. The at least one magnetoresistor is positioned with respect to the non-ferromagnetic compressor wheel and the permanent magnet so as to be magnetically biased by the permanent magnet and so as to sense rotation of the non-ferromagnetic compressor wheel.

Behrens discloses in Figure 1 a housing 1 of a turbocharger. The housing 1 has a non-magnetic housing wall 2. Aluminum compressor blades 6 rotate within the housing 1 on one side of the housing wall 2. A magnet 9 and a coil 10 around the magnet 9 are located on the other side of the housing wall 2.

The magnet 9 produces field lines that impinge at a right angle on the compressor blades 6. Currents are induced in the compressor blades 6 as they move

across the field lines. These induced currents produce a secondary magnetic field that counteracts or damps the magnetic field produced by the magnet 9 and induces a current in the coil 10. This current induced in the coil 10 indicates the rotational speed of the turbocharger.

As can be seen, Behrens does not disclose the use of a magnetoresistor that is magnetically biased by the magnet 9 and that senses rotation of a compressor wheel. Accordingly, the Examiner has relied on Nath.

Nath discloses a method of inspecting a coated component 20, such as an airfoil of a turbine engine, by use of an eddy current. A drive pulse supplied by a drive coil 12 is applied at a measurement position 28 on an outer surface 11 of the coated component 20. The drive pulse generates a primary magnetic field, which induces an eddy current within the coated component 20. The eddy current in turn generates a secondary magnetic field that is sensed by the magnetic field sensor 14. The magnetic field sensor 14 may be a giant magnetoresistive (GMR) sensor.

The presence of a crack 52 in the coated component 20 changes the flow of the eddy current within the coated component 20. The altered eddy current, in turn, produces a modified secondary magnetic field, which

is detected by the magnetic field sensor 14. The signal produced by the magnetic field sensor 14 is compared to a reference. The crack 52 is detected on the basis of this comparison.

The airfoil 20 may be stationary or may be mounted on a rotor disk 30, which is attached to a rotor 10 positioned in the turbine engine. In this latter case, the drive coil 12 and the magnetic field sensor 14 are retracted prior to rotation of the rotor disk 30 in order to protect the drive coil 12 and the magnetic field sensor 14 from damage.

The Examiner asserts that it would have been obvious to use the magnetic field sensor 14, which might be a giant magnetoresistor, in place of the coil 10 disclosed in Behrens.

However, independent claim 1 also recites that the magnetoresistor is positioned with respect to the permanent magnet so as to be magnetically biased by the permanent magnet. Behrens is silent on this feature since it does not disclose the use of a magnetoresistor. Although Nath states that the magnetic field sensor 14 can be a giant magnetoresistor, Nath does not disclose or suggest biasing the giant magnetoresistor with any device, much less with a permanent magnet.

Accordingly, even if it had been obvious to use a magnetoresistor in place of the coil 10 shown in Behrens (which applicants do not concede), it would not have been obvious in view of Nath to position the magnetoresistor so as to be biased by the permanent magnet 9 of Behrens.

For this reason, independent claim 1 is not unpatentable over Behrens in view of Nath.

Moreover, the Examiner has offered no valid motivation as to why one of ordinary skill in the art would have combined Behrens and Nath as suggested by the Examiner. Accordingly, the Examiner has not made out a prima facie case of obviousness with respect to independent claim 1.

Therefore, for this reason also, independent claim 1 is not unpatentable over Behrens in view of Nath.

Because independent claim 1 is not unpatentable over Behrens in view of Nath, dependent claim 2 is likewise not unpatentable over Behrens in view of Nath.

In section 5 of the Office Action, the Examiner rejected claims 3 and 4 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Cila.

Cila discloses a magnetic pick up 10 that includes a hexagonal housing 12 attached to a threaded connector stud 14 at one end and a threaded hollow stud 16 at its other end. The threaded hollow stud 16 contains a permanent magnet 22 having a pair of magnetoresistors 26 and 28 at its tip coupled to leads 28 and 29 for connection to an electrical circuit within the housing 12. The magnetoresistors 26 and 28 detect ferromagnetic gear teeth 32 as the gear teeth 32 pass by the magnetoresistors 26 and 28. The threaded hollow stud 16 and a lock nut 18 are used to mount the magnetic pick up to a support.

As discussed above, neither Behrens nor Nath discloses or suggests biasing a magnetoresistor the permanent magnet that generates the eddy current. Moreover, Cila is silent on using the permanent magnet 22 to bias the magnetoresistors 26 and 28. It is noted that, as shown in the drawings of Cila, the permanent magnet 22 is in proximity to the magnetoresistors 26 and 28. However, such proximity does not of itself mean that the magnetoresistors 26 and 28 will be properly biased by the permanent magnet 22.

Accordingly, it would not have been obvious in view of Nath and Cila to position a magnetoresistor so as to be biased by the permanent magnet 9 of Behrens.

For this reason, independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Cila.

Because independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Cila, dependent claims 3 and 4 are likewise not unpatentable over Behrens in view of Nath and further in view of Cila.

In section 6 of the Office Action, the Examiner rejected claims 5-7 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Takizawa.

Takizawa discloses a wheel rotation detecting device having a hub 4 with a flange 10. A wheel and a disk rotor of a brake are fixed to a flange 10. An outside inner ring raceway 7 is formed on the outer periphery of the hub 4, and an inside inner ring raceway 7 is formed in an inner ring 5 fixed to a stepped portion 16 provided in the hub 4. An outer ring 1 includes a double row of outer ring raceways 6, and balls 8 are interposed between the outer ring raceways 6 and the inner ring raceways 7 so that a rotary ring 3 that

includes the hub 4 is rotatably supported by the outer ring 1.

An encoder 13 is supported on the hub 4. A sensor unit 20 is supported on the outer ring 1. The sensor unit 20 can be fixed to the outer ring 1 by screwing a flange 22 formed in the upper end of the sensor unit 20 to the outer ring 1. The sensor unit 20 includes a rotation detecting sensor 25 and a temperature sensor 26. The rotation detecting sensor 25 comprises a magnetic detection element 27, a permanent magnet 28, and a waveform shaping circuit 29. The magnetic detection element 27 can be a magnetoresistor. The temperature sensor 26 detects the temperature of the space 12 within which the balls 8 are disposed.

The encoder 13 is formed of a magnetic metal material having gear-shaped portions that cause the sensed magnetic characteristics to vary alternately and at regular intervals with respect to the circumferential direction. Accordingly, the rotation detecting sensor 25 detects the rotation speed and/or rotation number of the wheel attached to the hub 4 by detecting these varying magnetic characteristics.

Figure 3 of Takizawa shows a sensor unit 20a having a vibration sensor 32 in addition to the magnetic

detection element 27, the permanent magnet 28, and the waveform shaping circuit 29. The vibration sensor 32 is supported on a substrate 33 along with a signal processing circuit 35.

As discussed above, neither Behrens nor Nath discloses or suggests biasing a magnetoresistor with any device much less a permanent magnet. Similarly, Takizawa is silent on using the permanent magnet 28 to bias the magnetoresistor 25. It is noted that, as shown in the drawings of Takizawa, the permanent magnet 28 is in proximity to the magnetoresistor 25. However, such proximity does not of itself mean that the magnetoresistor 25 will be properly biased by the permanent magnet 28.

Accordingly, it would not have been obvious in view of Nath and Takizawa to position a magnetoresistor so as to be biased by the permanent magnet 9 of Behrens.

For this reason, independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Takizawa.

Because independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Takizawa, dependent claims 5-7 are likewise not

unpatentable over Behrens in view of Nath and further in view of Takizawa.

In section 7 of the Office Action, the Examiner rejected claims 8 and 9 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Stolfus.

Stolfus shows in Figure 4 a sensor ring 21 having a constant clearance between a pole piece 23 of a sensor coil 22 and each tip of the sensor ring 21. The electromagnetic coil 22 receives a magnetic flux change caused by the changing clearance between the sensor coil 22 and the successive tips and grooves of the sensor ring 21.

Stolfus also shows in Figure 5 a vehicle speed sensor conditioning circuit 100. The circuit 100 includes a flip-flop 108/110, a binary counter 112, and a transistor 122. A sensor output 124 is connected to the clock input of the circuit 108. The circuit 100 functions to divide a sensor output by 12 in order to improve the duty cycle output of a vehicle speed sensor circuit. The circuit 100 is generally configured to provide a particular number of pulses per distance of vehicle travel.

Figure 6 of Stolfus depicts a flow chart having a block 202 at which the vehicle speed sensor circuit 100 provides a particular number of pulses per distance of vehicle travel. At block 204, the vehicle speed sensor circuit 100 is configured so that the output of the speed sensor is divided by a particular value. At block 206, different values are placed on the parallel load pins of the binary counter 112 which permits the sensor output to be divided by placing different values on the parallel load pins. At block 208, a flip-flop is utilized to trigger on negative edges. Negative-edge spacing is thus independent of a sensor air gap, as indicated at block 210. The output of the circuit 100 is thus near 50% duty cycle as indicated at block 212.

As discussed above, neither Behrens nor Nath discloses or suggests biasing a magnetoresistor with any device much less a permanent magnet. Similarly, Stolfus is silent on using a permanent magnet to bias a magnetoresistor.

Accordingly, it would not have been obvious in view of Nath and Stolfus to position a magnetoresistor so as to be biased by the permanent magnet 9 of Behrens.

For this reason, independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Stolfus.

Because independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Stolfus, dependent claims 8 and 9 are likewise not unpatentable over Behrens in view of Nath and further in view of Stolfus.

In section 8 of the Office Action, the Examiner rejected claims 10 and 11 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Cila.

As discussed above, Behrens, Nath, Stolfus, and Cila do not disclose or suggest biasing a magnetoresistor with a permanent magnet. Accordingly, it would not have been obvious to one of ordinary skill in the art to combine these references so as to produce the invention of independent claim 1.

For this reason, independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Cila.

Because independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of

Stolfus and still further in view of Cila, dependent claims 10 and 11 are likewise not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Cila.

In section 9 of the Office Action, the Examiner rejected claims 12 and 13 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Takizawa.

As discussed above, Behrens, Nath, Stolfus, and Takizawa do not disclose or suggest biasing a magnetoresistor with a permanent magnet. Accordingly, it would not have been obvious to one of ordinary skill in the art to combine these references so as to produce the invention of independent claim 1.

For this reason, independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Takizawa.

Because independent claim 1 is not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Takizawa, dependent claims 12 and 13 are likewise not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Takizawa.

In section 10 of the Office Action, the Examiner rejected claims 14-18 and 25 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Takizawa.

Independent claim 14 is directed to an apparatus having a non-ferromagnetic compressor wheel of a turbocharger, a magnetic field sensor housing, a permanent magnet, and an active magnetic field sensor. The non-ferromagnetic compressor wheel has fins. The magnetic field sensor housing is attached to a structure in proximity to the non-ferromagnetic compressor wheel. The permanent magnet is disposed within the magnetic field sensor housing and is positioned so as to induce eddy currents on the fins. The active magnetic field sensor is disposed within the magnetic field sensor housing and is positioned with respect to the non-ferromagnetic compressor wheel and the permanent magnet so as to be magnetically biased by the permanent magnet and so as to sense a magnetic field induced by the eddy currents to thereby detect rotation of the non-ferromagnetic compressor wheel.

As indicated above, Behrens, Nath, and Takizawa do not disclose or suggest using permanent magnet to bias an active magnetic field sensor.

Accordingly, it would not have been obvious in view of Nath and Takizawa to position a magnetoresistor so as to be biased by the permanent magnet 9 of Behrens.

For this reason, independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa.

Because independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa, dependent claims 15-18, 23, and 25 are likewise not unpatentable over Behrens in view of Nath and further in view of Takizawa.

Moreover, the Examiner has offered no valid motivation as to why one of ordinary skill in the art would have combined Behrens and Nath as suggested by the Examiner.

Accordingly, the Examiner has not made out a prima facie case of obviousness with respect to independent claim 14. Therefore, for this reason also, independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa.

Because independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa for this additional reason, dependent claims 15-18, 23, and 25 are likewise not unpatentable

over Behrens in view of Nath and further in view of Takizawa.

In section 11 of the Office Action, the Examiner rejected claim 24 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Adelerhof.

Adelerhof discloses an AMR sensor 3 located on the side of a soft magnetic target wheel 1 that is provided with teeth 5 about its circumference. A bias magnet 2 biases the sensor 3. The magnetic field emanating from the magnet 2 passes the sensor 3 in the direction towards a shaft 4 if the sensor is between two teeth, or the magnetic field is bent towards the target wheel 1 if the sensor 3 is next to a tooth. The change in field direction is sensed by the sensor 3.

As indicated above, Behrens, Nath, and Takizawa do not disclose or suggest using a permanent magnet both to induce an eddy current on the fins of a non-ferromagnetic compressor wheel and to bias the magnetoresistor that senses the field produce by the eddy current. Similarly, Adelerhof does not disclose or suggest using permanent magnet both to induce an eddy current on the fins of a non-ferromagnetic compressor

wheel and to bias the magnetoresistor that senses the field produce by the eddy current.

Accordingly, it would not have been obvious to one of ordinary skill in the art to combine Behrens, Nath, Takizawa, and Adelerhof so as to produce the invention of independent claim 14.

For this reason, independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Adelerhof.

Because independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Adelerhof, dependent claim 24 is likewise not unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Adelerhof.

In section 12 of the Office Action, the Examiner rejected claims 19-22 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Stolfus.

As discussed above, Behrens, Nath, Takizawa, and Stolfus do not disclose or suggest biasing a magnetoresistor with a permanent magnet. Accordingly, it would not have been obvious to one of ordinary skill in

the art to combine these references so as to produce the invention of independent claim 14.

For this reason, independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Stolfus.

Because independent claim 14 is not unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Stolfus, dependent claims 19-22 are likewise not unpatentable over Behrens in view of Nath and further in view of Takizawa and still further in view of Stolfus.

In section 13 of the Office Action, the Examiner rejected claims 26-32 and 35 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Stolfus.

Independent claim 26 is directed to a method of sensing rotation of a non-ferromagnetic compressor wheel of a turbocharger comprising inducing eddy currents in fins of the non-ferromagnetic compressor wheel, sensing a magnetic field induced by the eddy currents by use of an active magnetic field sensor so as to produce pulses having a pulse rate dependent upon a speed at which the non-ferromagnetic compressor wheel rotates, and reducing the pulse rate so as to provide a consistent pulse rate

regardless of the number of the fins of the non-ferromagnetic compressor wheel.

Behrens, Nath, and Stolfus do not disclose or suggest reducing the pulse rate so as to provide a consistent pulse rate regardless of the number of the fins of the non-ferromagnetic compressor wheel.

Stolfus does state that it is desirable to configure a vehicle speed sensor circuit to provide a certain exact number of pulses per mile of vehicle travel, and that it is also often a requirement of vehicle speed sensor users to obtain an output duty cycle at or very near a fifty-percent (50%) duty cycle.

However, configuring a vehicle speed sensor circuit to provide a certain exact number of pulses per mile of vehicle travel has nothing to do with the number of fins of a non-ferromagnetic compressor wheel. Indeed, the rotation of a non-ferromagnetic compressor wheel has no relationship to distance.

Moreover, having a 50% output duty cycle similarly does not have anything to do with the number of fins of a non-ferromagnetic compressor wheel. The duty cycle merely means the relationship between the high time and the low time of the output pulse and does not bear any relationship to the number of output pulses. Indeed,

the number of output pulses could vary from revolution to revolution and yet the duty cycle would remain the same.

Accordingly, the combination of Behrens, Nath, and Stolfus does not suggest the invention of independent claim 26. Therefore, independent claim 26 is not unpatentable over Behrens in view of Nath and further in view of Stolfus.

Because independent claim 26 is not unpatentable over Behrens in view of Nath and further in view of Stolfus, dependent claims 27-33 and 35 are likewise not unpatentable over Behrens in view of Nath and further in view of Stolfus.

In section 14 of the Office Action, the Examiner rejected claim 34 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Adelerhof.

Adelerhof likewise does not suggest reducing the pulse rate so as to provide a consistent pulse rate regardless of the number of the fins of the non-ferromagnetic compressor wheel.

Accordingly, the combination of Behrens, Nath, Stolfus, and Adelerhof does not suggest the invention of independent claim 26. Therefore, independent claim 26 is

not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Adelerhof.

Because independent claim 26 is not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Adelerhof, dependent claim 34 is likewise not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Adelerhof.

In section 15 of the Office Action, the Examiner rejected claim 36 under 35 U.S.C. §103(a) as being unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Hartman.

Hartman discloses a turbo-charged natural gas engine system 10 including a turbocharger compressor 12 which provides pressure boosted air to an intercooler 14, and then via an air throttle 16 to a natural gas engine 18. A natural gas supply 4 supplies fuel to an injector 6, which in turn, supplies fuel to an air/fuel mixer 8. Engine exhaust flows from the engine 18 to a turbocharger turbine 20 and to a valve 22, and then to an exhaust 24.

An air pressure sensor 26 senses air pressure at an intake of the compressor 12, an air pressure sensor

28 senses air pressure at an outlet of the intercooler 14, and an intake manifold pressure sensor 30 senses air pressure at the intake manifold of the engine 18. A humidity sensor 32 senses intake air humidity. A temperature sensor 34 senses intake air temperature, and a temperature sensor 36 senses manifold air temperature upstream of the air throttle 16. An oxygen sensor 38 senses oxygen in the exhaust 24.

An electronic control unit 40 periodically executes algorithms so as to reduce turbocharger surge in an engine.

As can be seen, Hartman does not disclose or suggest reducing a pulse rate produced by a sensor in order to provide a consistent pulse rate regardless of the number of fins of a non-ferromagnetic compressor wheel.

Because Behrens, Nath, and Stolfus likewise do not disclose or suggest reducing a pulse rate produced by a sensor in order to provide a consistent pulse rate regardless of the number of fins of a non-ferromagnetic compressor wheel, it would not have been obvious to one of ordinary skill in the art to combine Behrens, Nath, Stolfus, and Hartman so as to produce the invention of independent claim 26.

Accordingly, independent claim 26 is not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Hartman.

Because independent claim 26 is not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Hartman, dependent claim 36 is likewise not unpatentable over Behrens in view of Nath and further in view of Stolfus and still further in view of Hartman.


CONCLUSION

In view of the above, it is clear that the claims of the present application are patentable over the references applied by the Examiner. Accordingly, allowance of these claims and issuance of the above captioned patent application are respectfully requested.

Respectfully submitted,

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